



# Forest Health Protection

## Pacific Southwest Region

### Northeastern California Shared Service Area

Date: September 6, 2016

File Code: 3420

To: District Ranger, Hat Creek Ranger District, Lassen National Forest

Subject: Evaluation of stand conditions with respect to forest insects and diseases in the Plum Restoration Project, Lassen National Forest (FHP Report NE16-10)

### **Summary**

At the request of Beth Waterston, Forester, VMS Enterprise Unit, Danny Cluck, Forest Health Protection (FHP) Entomologist and Bill Woodruff, FHP Plant Pathologist visited the Plum Restoration Project on May 6, 2016. The objective of this visit was to evaluate current stand conditions, determine the impacts of forest insects and diseases on management objectives and discuss proposed alternatives. Recommendations provided in this report will assist in the formulation of silvicultural prescriptions aimed at reducing stand density and increasing resiliency to disturbance events such as fire, insects and diseases.

### **Key findings:**

- Overstocking is putting many stands at risk to high levels of bark beetle-caused tree mortality during periods of drought.
- Recent tree mortality is at a high level for white fir, with slightly elevated levels of mortality for ponderosa pine.
- Aerial detection surveys in 2015, which provided a project-wide assessment of current conditions, also recorded elevated levels of tree mortality in some stands.
- The variable density thinning and prescribed fire treatments that are proposed should effectively reduce stocking to levels that lower the risk to bark beetle-caused mortality.

### **Description of the project area**

The Plum Restoration Project is located 3 miles northeast of Old Station, CA (40.709227 and 121.395718). The elevation of the project area ranges from approximately 4,800 to 5,400 feet

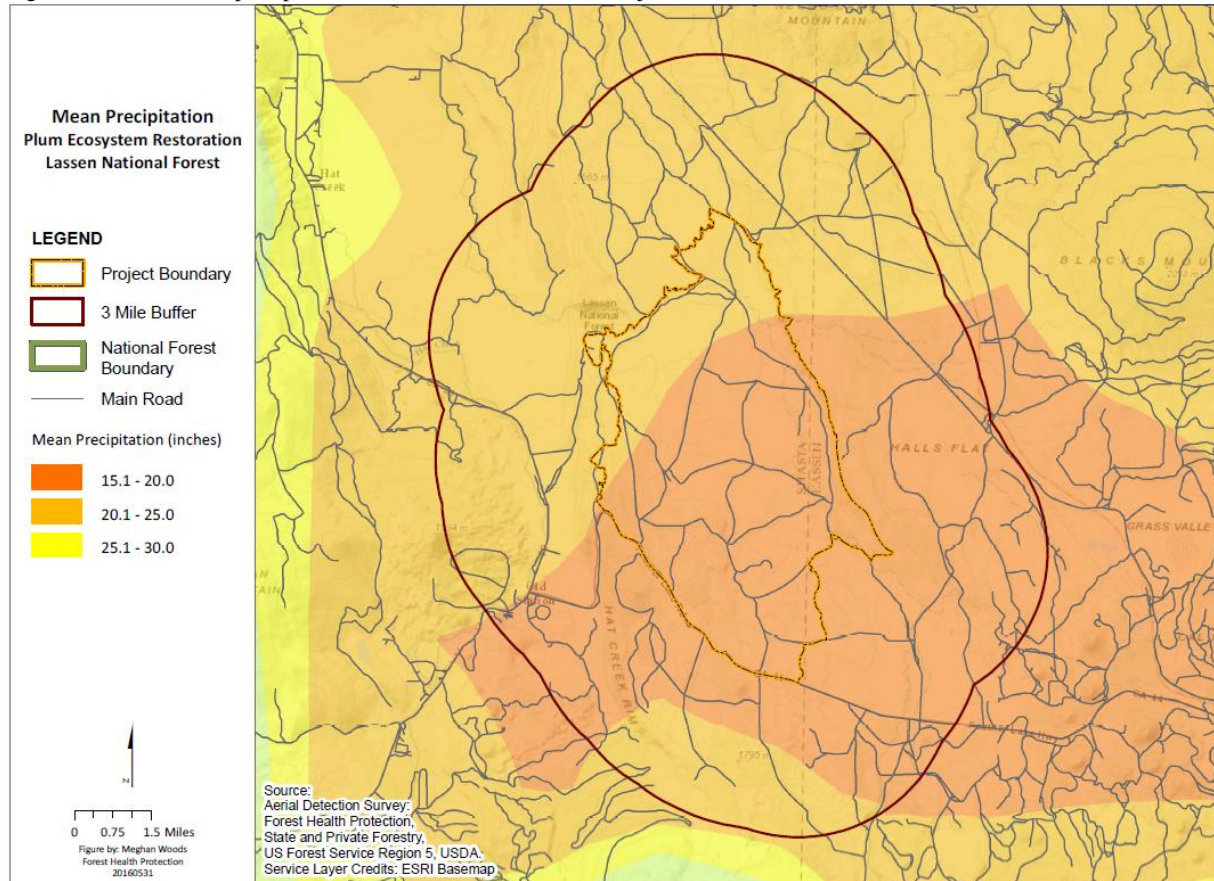
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with average annual precipitation ranging from 15 – 25 inches (Figure 1). Existing forest type is predominantly ponderosa pine (*Pinus ponderosa*) and Jeffrey pine (*Pinus jeffreyi*) with scattered western juniper (*Juniperus occidentalis*). There is also a small area of mixed conifer comprised of ponderosa pine, Jeffrey pine, sugar pine (*Pinus lambertiana*), incense cedar (*Calocedrus decurrens*) and white fir (*Abies concolor*). Most stands are overly dense with some containing scattered old growth pine species.

Figure 1. Mean annual precipitation for the Plum Restoration Project area.



## Management objectives

The management objectives for this project are to reduce stand density and fuels through variable density thinning and prescribed burning. Variable thinning would reduce stand density and change species composition to a more sustainable condition by removing trees from all size classes (< 30" dbh), creating openings and clumps, and removing competition from around old growth trees. Thinning would also be used to enhance sage flats and meadow complexes. This type of treatment would begin to move these stands to a more resilient condition that is consistent with Regional ecosystem restoration goals.

## Forest insect and disease conditions

Tree mortality attributable to forest insects and/or diseases is occurring at moderate to low levels in most of the areas covered during this evaluation. However, white fir growing within the

project area has experienced very high levels of mortality caused by the fir engraver beetle (*Scolytus ventralis*).

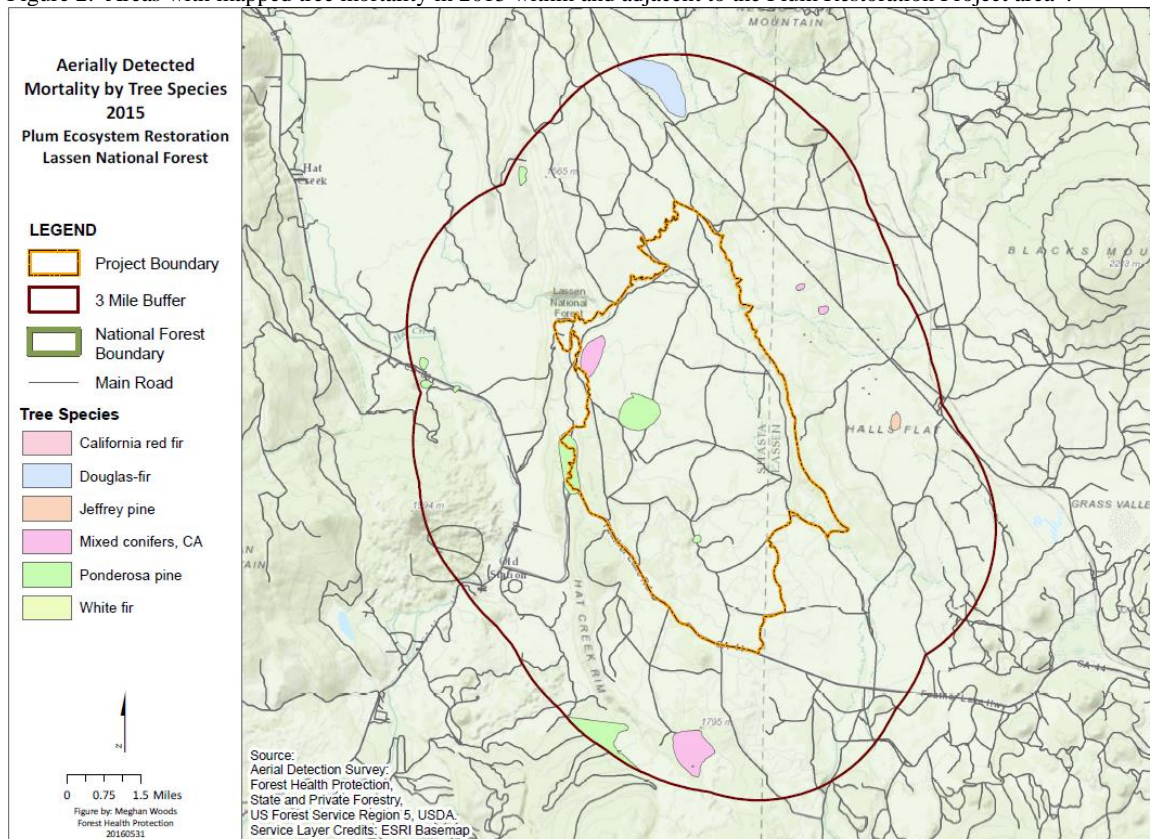
Ponderosa pine mortality, caused by the western pine beetle (*Dendroctonus brevicomis*), was observed next to Plum Valley Reservoir as well as in areas that burned in the 2009 Sugarloaf Fire.

Elytroderma disease caused by (*Elytroderma deformans*) was observed in ponderosa and Jeffrey pine in a few locations.

A minor black pineleaf scale outbreak (*Nuculaspis californica*) occurred in 2014 in the area of Plum Valley Reservoir. Trees with poor needle retention are still evident at this location.

The 2015 aerial survey documented an increase in tree mortality within and adjacent to the project area consistent with the ongoing drought and overly dense stand conditions (Figure 2).

Figure 2. Areas with mapped tree mortality in 2015 within and adjacent to the Plum Restoration Project area\*.



\*Some tree mortality incorrectly classified as Douglas-fir mortality on this map.

### **Stand conditions and mortality related to recent and future climate trends**

Most of the stands within and adjacent to the Plum Restoration Project appear to be at or above “normal” stocking levels and have exhibited elevated levels of tree mortality caused by bark beetles during and after periods of drought. This mortality combined with high stand density has



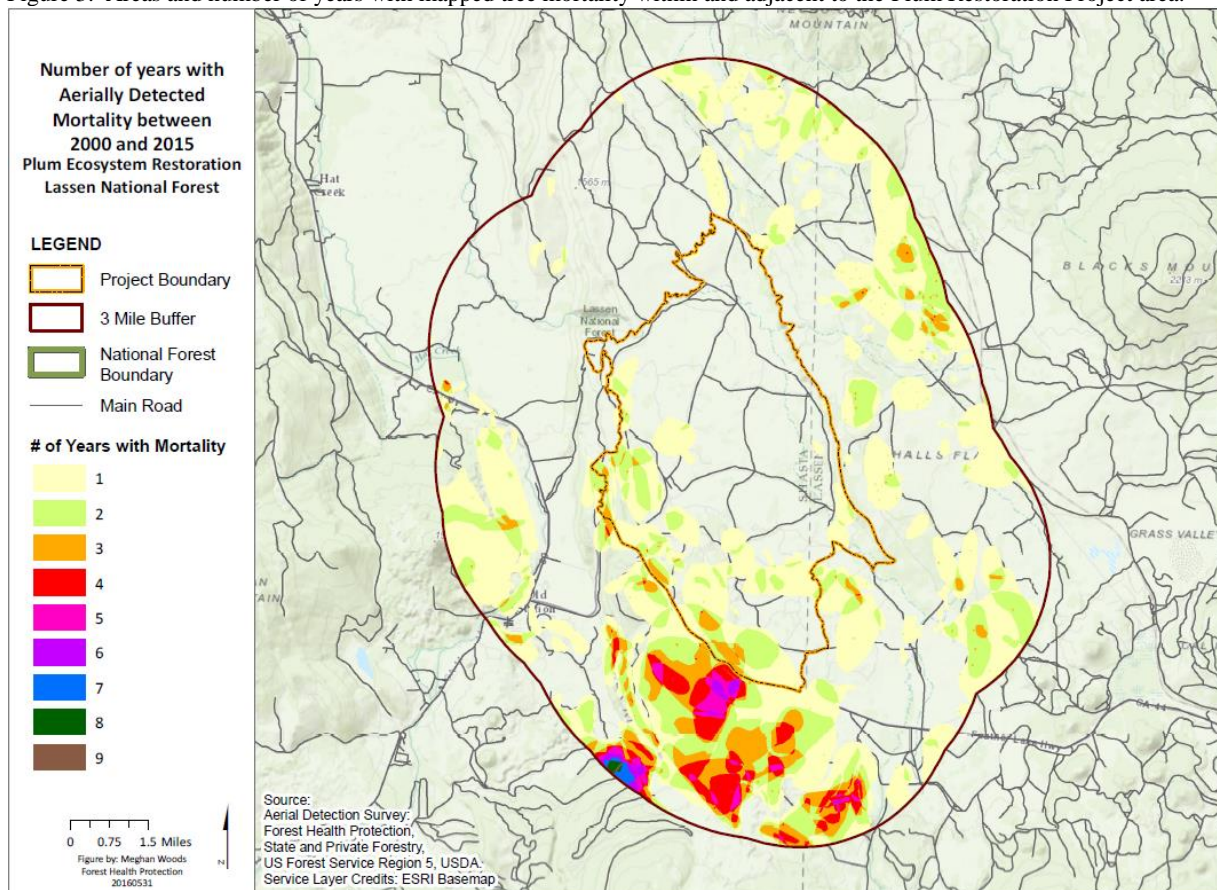
resulted in heavy fuel loading in many areas and a corresponding increase in potential fire behavior.

The entire project area receives less than 25 inches of annual precipitation (Figure 1). This is well below what is generally required for healthy white fir forests to exist over the long-term. Therefore, even at the lowest stocking levels, white fir growing on these sites are at extreme risk for fir engraver beetle-caused mortality during periods of drought (Schultz FHP Report 1994).

Aerial detection surveys conducted by Region 5 Forest Health Monitoring have detected various levels of tree mortality caused by bark beetles nearly every year from 2006 to 2015 within and adjacent to the project area. Most of this mortality occurred in response to drought conditions and was caused by the same bark beetle species observed during this evaluation (Figure 3 and Table 1).

Figure 3 also depicts many areas where no mortality was mapped during the past 10 years. However, many stands do exist within this “mortality free” zone that are at a high risk to bark beetle-caused tree mortality due to overstocked conditions and could experience unacceptable levels of tree mortality during prolonged and/or severe drought (Figure 4). Anticipating future drought events and reducing tree density to levels that are more resilient and sustainable should reduce the risk of unacceptable levels of tree mortality within the project area.

Figure 3. Areas and number of years with mapped tree mortality within and adjacent to the Plum Restoration Project area.



**Table 1.** Acres with mortality, estimated dead trees per acre and estimated total # of dead trees from R5 Aerial Detection Surveys and Palmer Hydrologic Drought Index (PHDI) (average of CA Divisions 2 and 3<sup>1</sup>) by water year (Oct-Sept) within and adjacent to the Plum Restoration Project area.

Year	Acres	Dead Trees/Acre	Total # of Dead Trees	PHDI <sup>2</sup>
2015	4,227	5.1	21,635	-3.34
2014	252	11.4	2,883	-3.56
2013	0	0	0	-2.16
2012	2,198	2.3	5,012	-0.59
2011	5,551	6.4	35,320	2.78
2010	6,301	8.0	50,153	-0.14
2009	2,533	2.4	6,193	-2.98
2008	407	1.3	526	-3.16
2007	40	1.4	55	-3.17
2006	17	2.3	38	2.40

<sup>1</sup> California Divisions 2 and 3 encompass most of northeastern California.

<sup>2</sup> PHDI values ranging from -2.00 to -2.99 are considered moderate drought conditions. Severe drought conditions range from -3.00 to -3.99 and extreme drought conditions are below -4.00.

Predicted climate change is likely to impact trees growing in the Plum Restoration Project area over the next 100 years. Although no Lassen National Forest specific climate change models are available at this time, there is a general consensus among California models that summers will be drier than they are currently. This prediction is based on the forecasted rise in mean minimum and maximum temperatures and remains consistent regardless of future levels of annual precipitation (K. Merriam and H. Safford, *A summary of current trends and probable future trends in climate and climate-driven processes in the Sierra Cascade Province, including the Plumas, Modoc, and Lassen National Forests*). The risk of bark beetle-caused tree mortality will likely increase for all conifer species under this scenario, especially drought intolerant white fir and overly dense stands of ponderosa and Jeffrey pine. Improving the resilience of stands to future disturbance events through density, size class and species composition management will be critical to maintaining a healthy forested landscape.

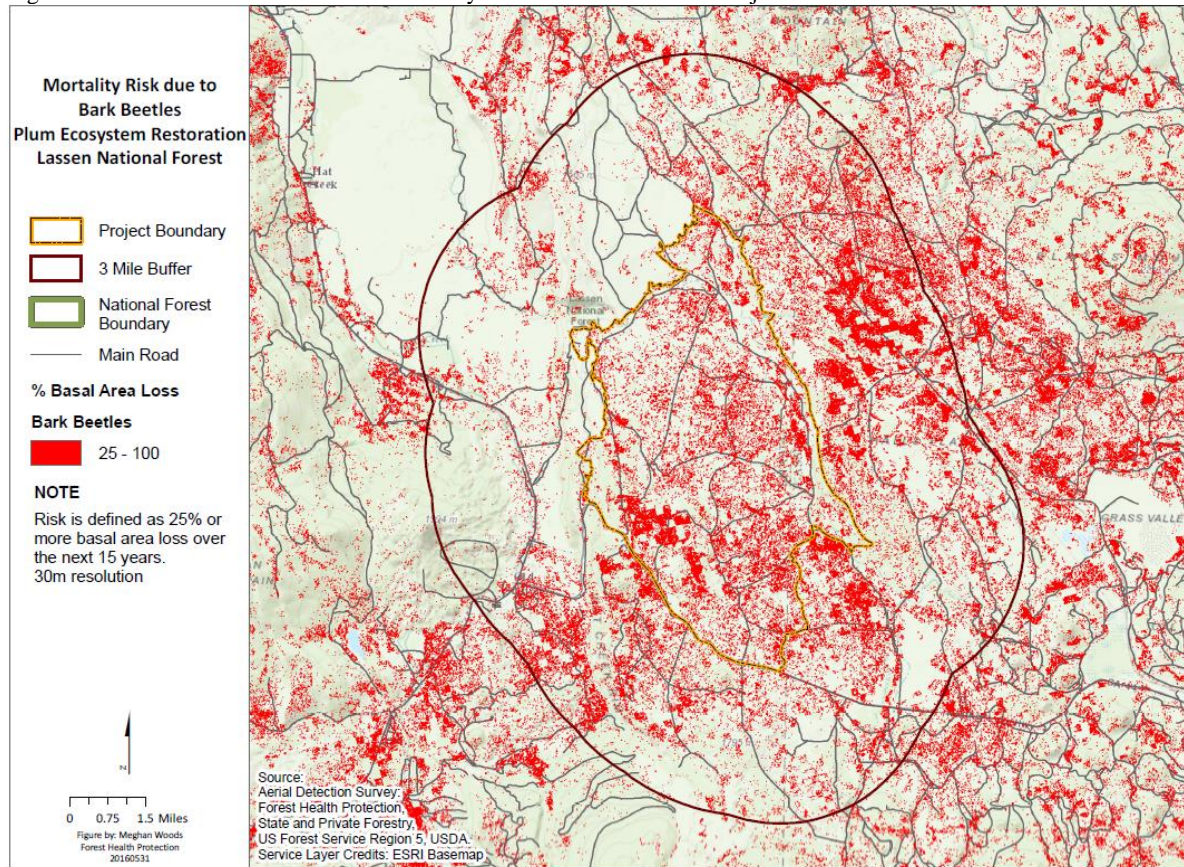
### **Considerations for thinning treatments**

The thinning treatments proposed by the District should reduce stand density to a level that significantly lowers the risk of bark beetle caused mortality. In most cases, thinning to a relative density of 25 - 40% (relative to the maximum Stand Density Index, or SDI) for a specific conifer species or for a weighted composition of conifer species will effectively reduce competition for limited water and nutrients and reduce the susceptibility to future bark beetle- caused tree mortality.

The District should consider using the bark beetle limiting SDI of 365 as a basis for thinning prescriptions in pine dominated stands. SDI 365 is considered the upper management zone above which bark beetle outbreaks are likely to occur and SDI 230 is considered the threshold for the zone of imminent bark beetle caused mortality. Within this zone, endemic populations kill a few trees but net growth is still positive (Oliver 1995). Planning thinning treatments that result in



Figure 4. Risk of bark beetle-cause tree mortality in the Plum Restoration Project.



stocking levels well below SDI 230 would greatly reduce the risk of bark beetle-caused mortality in these areas. Cutting and removing white fir in favor of other tree species is highly recommended.

When planning thinning treatments, it should be recognized that the target stand density is an average to be applied across the landscape and some variability may be desired. Individual high value trees, such as mature pines, should benefit by having the stocking around them reduced to lower levels. Areas of ponderosa and/or Jeffrey pine would also benefit from lower stocking levels. Where they coexist, both species should be maintained in the stand as much as possible. Removing trees that are severely infected with *Elytroderma* needle cast would also improve overall stand health.

Some stands within the project area contain scattered large diameter ponderosa and Jeffrey pine. Thinning treatments that improve growing conditions for these old trees, such as removing a large percentage of existing competition, would increase their health and vigor, create opportunities for their successful regeneration. Removing competing trees from the base of large diameter pines combined with stand level thinning has resulted in a measured increase in annual increment growth in old growth ponderosa and Jeffrey pine on the Lassen National Forest (FHP unpublished data).

It is recommended that a registered borate compound be applied to all freshly cut pine stumps >14" in diameter to reduce the chance of creating new infection centers of *Heterobasidion irregulare*, formerly referred to as P-type annosus root disease, through harvest activity. Treatment of white fir stumps is not necessary as white fir should be selected against in all thinning operations and is not a desirable species component within the project area.

Sugar pine should be retained as much as possible during any thinning operation in order to preserve genetic diversity, especially white pine blister rust (*Cronartium ribicola*) resistant individuals. White pine blister rust, a non-native pathogen, has continued to weaken and kill this species over most of its range since its introduction into the Pacific Northwest in 1910. Identification and protection of local rust resistant trees for seed collection, if not already occurring, will aid in the future planting of rust resistant seedlings. Planting selected openings created through thinning operations with rust resistant stock would help insure this species persists in the area.

### **Considerations for Rx fire**

If prescribed fire is used as a follow-up treatment to stand thinning, it may result in unacceptable levels of tree mortality; depending on management objectives. This mortality most often occurs as a direct result of cambium or crown injury to individual trees during the fire. Mature ponderosa, Jeffrey and especially sugar pines are susceptible to lethal basal cambium damage during prescribed burns from the heat that develops in the deep duff and litter that accumulates at their bases. These duff mounds typically burn at a slow rate with lethal temperatures, causing severe injury to the cambium which girdles the trees. To protect individual high-value large diameter pine from lethal cambium damage, raking the duff away from the bases of these trees before burning (within 24" of the bole and down to mineral soil) is recommended.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-252-6431.

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## **Insect and Disease Information**

### **Fir Engraver**

The fir engraver attacks red and white fir in California. Fir engraver adults and developing broods kill true firs by mining the cambium, phloem, and outer sapwood of the bole, thereby girdling the tree. Trees greater than 4" in diameter are attacked and often killed in a single season. Many trees, weakened through successive attacks, die slowly over a period of years. Others may survive attack as evidenced by old spike-topped fir and trees with individual branch mortality. Although many other species of bark beetles cannot develop successful broods without killing the tree, the fir engraver beetle is able to attack and establish broods when only a portion of the cambium area has been killed.

#### **Evidence of Attack**

Fir engravers bore entrance holes along the main stem, usually in areas that are > 4" in diameter. Reddish-brown or white boring dust may be seen along the trunk in bark crevices and in spider webs. Some pitch streamers may be indicative of fir engraver attacks; however, true firs are known to stream pitch for various reasons and there is not clear evidence that pitch streamers indicate subsequent tree mortality or successful attack. Resin canals and pockets in the cortex of the bark are part of the tree's defense mechanism. Beetle galleries that contact these structures almost always fail to produce larval galleries as the adults invariably abandon the attack. Pitch tubes, often formed when bark beetles attack pine, are not produced on firs.

Adults excavate horizontal galleries that engrave the sapwood; the larval galleries extend at right angles along the grain. Attacks in the crown may girdle branches resulting in individual branch mortality or "flagging". Numerous attacks over part or the entire bole may kill the upper portion of the crown or the entire tree. A healthy tree can recover if sufficient areas of cambium remain and top-killed trees can produce new leaders. The fir engraver is frequently associated with the roundheaded fir borer and the fir flatheaded borer.

#### **Life Stages and Development**

In the summer, adults emerge and attack new host trees. The female enters the tree first followed by the male. Eggs are laid in niches on either side of the gallery. Adult beetles carry the brown staining fungi, *Trichosporium symbioticum*, into the tree that causes a yellowish-brown discoloration around the gallery. The larvae mine straight up and down, perpendicular to the egg gallery. Winter is commonly spent in the larval stage, with pupation occurring in early spring. In most locations, the fir engraver completes its life cycle in 1 year, however at higher elevations 2 years may be required.

#### **Conditions Affecting Outbreaks**

Fir engravers bore into any member of the host species on which they land but establish successful galleries only in those that have little or no resistance to attack. Populations of less aggressive species like fir engraver are likely to wax and wane in direct relationship to the stresses of their hosts. Drought conditions often result in widespread fir mortality; however, attempting to determine when outbreaks will occur is difficult. Lowered resistance of trees appears to be a contributing factor. Overstocking and the increased presence of fir on sites that were once occupied by pine species may also contribute to higher than normal levels of fir mortality. Several insect predators, parasites and woodpeckers are commonly associated with the fir engraver and may help in control of populations at endemic levels.



## **Western Pine Beetle**

The western pine beetle, *Dendroctonus brevicornis*, has been intensively studied and has proven to be an important factor in the ecology and management of ponderosa pine throughout the range of the host species (Miller and Keen 1960). This insect breeds in the main bole of living ponderosa pine larger than about 8 inches DBH. Normally it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire. Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year.

### **Evidence of Attack**

Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pitch tubes are formed on the tree trunk around the entry holes. Successful pitch tubes are red-brown masses of resin and boring dust. Relatively few, widely scattered white pitch tubes usually indicate that the attacks were not successful and that the tree should survive. Pheromones released during a successful attack attract other conspecifics. Attracted beetles may then spill over into nearby apparently healthy trees and overwhelm the tree with sheer numbers.

### **Life Stages and Development**

These beetles pass through the egg, larval, pupal and adult stages during a life cycle that varies in length dependent primarily on temperature. Adults bore a sinuous gallery pattern in the phloem and the female lays eggs in niches along the sides of the gallery. The larvae are small white grubs that first feed in the phloem then mine into the middle bark where they complete most of their development. Bluestain fungi inoculates the tree during successful attacks, blocking trachids and vessels which contribute to the rapid tree mortality associated with bark beetle attacks.

### **Conditions affecting Outbreaks**

Outbreaks of western pine beetle have been observed, and surveys made, in pine regions of the West since 1899 (Hopkins 1899; cited in Miller and Keen 1960). An insect survey completed in 1917 in northern California indicated that over 25 million board feet of pine timber had been killed by bark beetles. Information from surveys conducted in the 1930's indicated enormous losses attributed to the western pine beetle around that time. During the 1930's outbreak, most of the mortality occurred in stands of mature or overmature trees of poor vigor (Miller and Keen 1960). Group kills do not typically continue to increase in size through successive beetle generations as is typical with Mountain Pine Beetle and Jeffrey Pine Beetle. Rather, observations indicate that emerging beetles tend to leave the group kill area to initiate new attacks elsewhere.

The availability of suitable host material is a key condition influencing western pine beetle outbreaks. In northeastern California, drought stress may be the key condition influencing western pine beetle outbreaks. When healthy trees undergo a sudden and severe moisture stress populations of western pine beetle are likely to increase. Healthy trees ordinarily produce abundant resin, which pitch out attacking beetles, but when deprived of moisture, stressed trees cannot produce sufficient resin to resist the attack. Any condition that results in excessive demand for moisture, such as inter-tree competition, competing vegetation, or protracted drought periods; or any condition that reduces the ability of the roots to supply water to the tree, such as mechanical damage, root disease or soil compaction, can cause moisture stress and increase susceptibility to attack by the western pine beetle.

Woodpeckers, predacious beetles, and low temperatures act as natural control agents when beetle populations are low (endemic populations).

### **White pine blister rust**

White pine blister rust is caused by *Cronartium ribicola* an obligate parasite that attacks 5-needled pines and several species of *Ribes* spp. The fungus needs the two alternate hosts to survive, spending part of its life on 5-needled pines and the other on *Ribes* spp. The disease occurs throughout the range of sugar pine to the southern Sierra Nevada, but has not been reported further south. Infection of pines results in cankers on branches and main stems, branch mortality, top kill, and tree mortality.

Spores (aeciospores) produced by the fungus in the spring on pine bole or branch cankers are wind-disseminated to *Ribes* spp. where they infect the leaves. Spores (urediospores) produced in orange pustules on the underside of the leaves reinfect other *Ribes* spp. throughout the summer, resulting in an intensification of the rust. A telial spore stage forms on *Ribes* spp. leaves in the fall. Teliospores germinate in place to produce spores (sporidia) which are wind-disseminated to pines and infect current year needles. Following infection, the fungus grows from the needle into the branch and forms a canker. After 2 or 3 years, spores are produced on the cankers and are spread to *Ribes* spp. to continue the cycle. Although blister rust may spread hundreds of miles from pines to *Ribes* spp., its spread from *Ribes* spp. back to pines is usually limited to a few hundred feet.

Branch cankers continue to enlarge as the fungus invades additional tissues and moves toward the bole. Branch cankers within 24 inches of the bole will eventually form bole cankers. Bole cankers result in girdling and death of the tree above the canker. Cankers that have margins more than 24 inches from the main bole are unlikely to reach the bole and only branch flagging will result.